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Feasibility of production of large-scale double-fortified salt with iodine and folic acid (DFS-IoFA) in Ethiopia

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Executive Summary

Neural tube defects (NTDs) remain a major public health concern in Ethiopia, largely driven by maternal folate insufficiency in early pregnancy.

Despite strong global evidence on the benefits of folic acid fortification, coverage in Ethiopia remains limited due to low industrial processing of staple foods like wheat flour. In contrast, iodized salt is widely consumed throughout Ethiopia, and may provide an excellent vehicle to deliver folic acid. To leverage this delivery platform, Nutrition International—working in collaboration with the Ethiopian Public Health Institute (EPHI), the University of California – Davis (UC Davis), and the University of Toronto (UofT) — tested the feasibility of producing double-fortified salt with iodine and folic acid (DFS-IoFA) at an industrial level, using the spray-based method currently used in all the Central Iodizing Facilities in the country.

Findings confirm that DFS-IoFA can be produced locally and at industrial scale with minimal infrastructure upgrades. Folic acid premix supply chain alternatives were identified to support DFS-IoFA premix supply. These studies present a cost-effective, scalable, and equitable strategy to improve folate status and hence reduce the risk of NTDs, thus improving maternal and child health across Ethiopia.

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The Problem

NTDs contribute to stillbirths and infant mortality in Ethiopia, with a burden of disease higher than any other African country. The leading cause is maternal folate insufficiency, which affects 57% of women in rural areas and 74% in urban areas. While large-scale food fortification (LSFF) with folic acid, mostly resorting to wheat flour, has proven effective globally to reduce the prevalence of NTDs, its reach in Ethiopia is limited. With iodized salt already reaching almost all households, adding folic acid presents a promising population-wide solution to address folate insufficiency. However, DFS-IoFA had never been produced at an industrial level in Ethiopia.

Production Approach

DFS-IoFA can offer a practical solution to extend the reach of LSFF by building on Ethiopia's existing salt iodization infrastructure. Nutrition International, in partnership with EPHI, UC Davis, and the UofT, developed and successfully tested a spray-based method to integrate folic acid into iodized salt—demonstrating its technical feasibility and compatibility with current processing systems.

Objectives & Methods

Several studies have been conducted to support the overall project. Two of these are presented here.

The objective of the first study was to test the feasibility of producing DFS-IoFA at industry level in Ethiopia, resorting to the spray technology used in all Central Iodizing Facilities in the country. More specifically, we aimed to produce DFS-IoFA with specific formulations required for a field trial of its biological efficacy. Three product variants were produced, to address the requirements of a subsequent efficacy trial: iodized-only salt (IS), low folic acid (LFA, 33 ppm), and high folic acid (HFA, 99 ppm), all containing 35 ppm iodine. A systematic assessment of all salt processing facilities operating in Ethiopia identified one optimal partner for production. Target concentration of both micronutrients was thoroughly assessed and their stability was monitored for ten months after production, stored under ambient conditions.

The objective of the second study was to identify short term and long-term options that ensure an uninterrupted supply of quality folic acid premix in Ethiopia. A qualitative content analysis approach and purposive sampling method were used to select 17 expert participants for focus group discussions and key informant interviews from 16 stakeholder organizations in Addis Ababa and Hawassa, based on participants' knowledge and level of involvement in the subject matter.

Key Findings

Study 1: Feasibility of production of large-scale Double-Fortified Salt with Iodine and Folic Acid (DFS-IoFA) in Ethiopia

- All 14 Central Iodization Facilities (CIFs) that were operational in Ethiopia at the time of the study have the basic infrastructure needed to produce DFS-IoFA; only minimal equipment upgrades are needed (e.g., spray nozzles, quality assurance/quality control (QA/QC) labs).
- The DFS-IoFA produced at the selected CIF met the target folic acid and iodine levels needed for the field trial.
- The retention of both micronutrients (iodine and folic acid) was > 94% after 10 months storage under ambient conditions (Table 1).
- Results from the efficacy trial (presented elsewhere) showed a significant impact in improving folate status in participants.
- Capacity-building training was delivered to 18 regulatory and technical personnel involved in the salt industry.

Table 1 Micronutrient retention in salt 10 months after production (ppm)

Micronutrients	Study Groups	Target	Initial	Final	% Retention
Folic Acid	HFS	99	104±2	96±2	94
	LSF	33	36±0	36±2	99
	IS	0	0	0	-
Iodine	HFS	30-40	32±1	31±2	96
	LFS	30-40	34±1	32±1	95
	IS	30-40	32±2	32±1	100

HFS: DFS -IoFA fortified with iodine and high folic acid

LFS: DFS -IoFA fortified with iodine and low folic acid

IS: Iodized Salt

Study 2: Folic acid supply chain and market analysis for Double Fortification of Salt with iodine and folic acid (DFS–IoFA)

- Four premix (folic acid supply) chain alternatives were identified as potential mechanisms to support DFS-IoFA premix supply (Table 2).
- DFS-IoFA attracts local private investors and international premix manufacturers and suppliers to invest in Ethiopia in premix production contributing to the national economy and effort against foreign deficits.
- Private laboratory analysis infrastructure is available in Ethiopia that can provide QA/QC support for quality of premix.

Table 2: Premix supply alternatives in Ethiopia

Alternatives	*Pros*	*Cons*
Supply through local production	• Favored by most stakeholders • Allows selling using local currency	• Needs long term to implement • Demand is low to foster initial investment
Import through private sector actors • International traders that have premix blending factory • International vitamin and vitamin premix manufacturers • Private businesses in Ethiopia engaged in the import of human medicine • Large scale salt iodization factories	• Can allocate foreign currency (Export side businesses) • Some already are engaged in importing vitamin concentrates to local pharmaceuticals • Some can sell using local currency • Better risk management capacity	• Support/incentive from government was requested • Sensitive to price fluctuation • Interested in maximizing profit
Import through government enterprises	• Have experience of supplying premix • Minimum profit margin applied • Distribution network and storage space available throughout the country	• Approval from National Bank of Ethiopia needed to allocate foreign currency • Some stakeholders believe that the government should not supply input to business owners • Long approval process when there is sudden price change
Supply through public-private partnership	• Reduced burden on the government • Better transportation and logistics security for private sector	• Managing the partnership may be difficult (disagreement in procedures)

Conclusions

This study confirms that Ethiopia can produce DFS-IoFA using the existing Central Iodization Facilities (CIFs), with minimal technical upgrades. When combined with demonstrated effectiveness in improving folate status and reducing the risk of NTDs, Ethiopia is well-positioned to scale a proven, high-impact intervention.

Large-scale implementation of DFS-IoFA could position Ethiopia as a regional leader in salt fortification, with export and economic potential offering a practical solution to folate deficiencies and NTDs in other settings, by building on Ethiopia's existing salt iodization infrastructure and by promoting local investment on premix supply.

Policy Recommendations

- Leverage existing salt iodization infrastructure to introduce DFS-IoFA at scale.
- Support producers with targeted investments in equipment and QA/QC systems.
- Integrate DFS-IoFA into Ethiopia's national LSFF strategy to improve maternal and child health.
- Position Ethiopia as a regional leader in salt fortification, with export and economic potential.

Policy Implications

Ethiopia is well-positioned to scale up a proven, high-impact intervention, consisting of large-scale fortification of salt with iodine and folic acid (DFS-IoFA). This intervention presents a cost effective and accessible approach to easily reach adult women of reproductive age and adolescent girls with folic acid and iodine, micronutrients that are essential in reduction of folate insufficiency, and hence significantly reduce the risk of pregnancies affected by NTDs. DFS-IoFA also prevents folate deficiency anemia and largely improves cognitive impairments due to iodine deficiency among children, reducing the prevalence of goitre and other iodine-deficiency disorders.

Provided that salt is consumed across every household in Ethiopia, the technology would be one of the best strategies to ensure equitable public health intervention to reduce these micronutrient deficiencies, regardless of socioeconomic and geographical disparities.

DFS-IoFA, if scaled at standard, would be a premier innovative approach in Africa that would motivate investment and export to the region which may contribute to increased human capital.

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